Session 2 Overview

Biomedical Systems

Chair: K. D. Wise, University of Michigan, Ann Arbor, MI

Associate Chair: Euisik Yoon, University of Minnesota, Minneapolis, MN

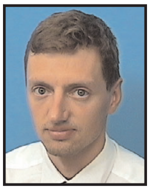
This session highlights electronic interfaces with bio-molecules and bio-signals. In these applications, solid-state electronic devices must operate in contact with bio-molecules and structures such as the auditory and optic nerves in the liquid phase. Hybrid sensor interface packaging and low-power low-noise analog front-end design combined with wireless data transmission are addressed in these papers for reliable detection of bio-signals.

The first two papers report fully-electronic non-optical CMOS-based DNA array chips. The first chip, described in Paper 2.1, detects bio-molecules by measuring time-resolved charge on the functionalized surface in an 24×16 electrochemical sensor array realized on top of 0.5μm CMOS circuits. The second chip, described in Paper 2.2, exploits label-free capacitive molecular detection on 128 interdigitated sensing electrodes. The sensing elements are integrated on the readout circuitry using post-CMOS processes.

A high-density thin-film cochlear electrode array with integrated electronics has been developed to improve pitch perception in restoring hearing to the profoundly deaf in Paper 2.3. This array offers the site densities needed for a 128-site 16-channel human array with embedded position sensing capability to minimize insertion damage.

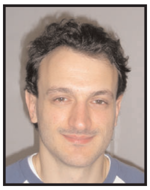
Papers 2.4 and 2.5 report wireless retinal implant prostheses. The first chip, described in Paper 2.4, realizes a digitally-programmable stimulation pad cell in $0.1mm^2$ for a 232 electrode stimulation array capable of operating at voltages up to ±15V. The second chip, described in Paper 2.5, achieves a low-power area-efficient implementation to deliver a data rate of 100kb/s using ASK modulation at 1.3mW.

The last two papers in the session address bio-signal acquisition systems. In Paper 2.6, a biopotential readout front-end for extracting EEG, ECG, and EMG signals with a total current dissipation of 20μA from 3V has been implemented with an input referred noise of $60nV/\sqrt{Hz}$ and CMRR of 120dB. In Paper 2.7, a low-voltage low-power biomedical signal acquisition IC consists of an LNA and an 11-bit ADC dissipating 2.3μW at 1V.



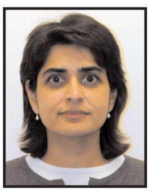
2.1 A 24×16 CMOS-Based Chronocoulometric DNA Microarray **1:30 PM**
M. Augustyniak, Infineon Technologies, Munich, Germany and Technical University Munich, Munich, Germany, now with Texas Instruments, Freising, Germany

An array of 24×16 electrochemical sensors for detecting bio-molecules uses gold sensor electrodes added to a 0.5μm CMOS process. Detection is based on time-resolved measurement of charge (Chronocoulometry). A differential measurement technique uses a replica electrode and fast integration to suppress background offset signals.



2.2 Fully Electronic CMOS DNA Detection Array based on Capacitance Measurement with On-Chip Analog-to-Digital Conversion **2:00 PM**
C. Stagni degli Esposti, University of Bologna, Bologna, Italy

An 8×16 array of sensing micro-sites employs a fully–electrical label-free technique for DNA recognition using capacitance measurement and is fabricated in 0.5μm CMOS with added noble metal. Repeatability and parallel detection capability have been demonstrated. The DNA-chip is suitable for low-cost, fully-integrated point-of-care applications.

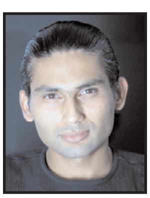


2.3 A 32-Site 4-Channel Cochlear Electrode Array **2:30 PM**
P. Bhatti, University of Michigan, Ann Arbor, MI

A thin-film cochlear electrode array has been developed to improve pitch perception and reduce insertion damage. A silicon-parylene substrate supports 32 IrO sites on 250μm centers along with circuitry for current generation and position sensing. Interfacing over eight leads at ±3V, stimulus pulses cover ±500μA with 8b resolution and a minimum pulse width of 4μs.

2.4 A 0.1mm^2 Digitally Programmable Nerve Stimulation Pad Cell with High-Voltage Capability for a Retinal Implant **3:15 PM**
M. Ortmanns, sciworx, Hannover, Germany

A 0.1mm^2 autonomous and digitally programmable nerve stimulation pad cell in 0.35μm HVCMOS is used in a 232-electrode retinal implant. It provides greater than ±15V swing at the electrode in order to supply suitable stimulation currents into large electrode impedances. Customized ESD protection is used on all electrodes. Charge balancing is applied to prevent electrolysis.



2.5 Minimally Invasive Retinal Prosthesis **3:45 PM**
L. Theogarajan, MIT, Cambridge, MA

A wireless retinal implant with a low-power area-efficient stimulator chip features an ASK demodulator, single-ended-to-differential converter, low-power DLL and programmable current drivers. The chip dissipates 1.3mW from ±2.5V at a data rate of 100kb/s. The chip is powered and driven through a wireless inductive link separated by 15mm.

2.6 A 60μW 60nV/√Hz Readout Front-End for Portable Biopotential Acquisition Systems **4:15 PM**
R. Yazicioglu, IMEC, Leuven, Belgium

A biopotential readout front-end can be configured to extract EEG, ECG, and EMG signals and draws 20μA from 3V. AC coupling of chopped amplifiers results in an input-referred noise of 60nV/√Hz and CMRR of 120dB at 1kHz. The immunity of the CMRR to electrode offset voltages is improved with an active input stage and 110dB CMRR is achieved at 100Hz with 50mV electrode offset.

2.7 A 1V 2.3μW Biomedical Signal Acquisition IC **4:45 PM**
H. Wu, National University of Singapore, Singapore

A 1V 2.3μW biomedical signal acquisition IC is fabricated in a 0.35μm CMOS process. It consists of an LNA and an 11b ADC. The OTA achieves an optimum trade-off between noise and power consumption with rail-to-rail output. A pseudo-S/H circuit is incorporated in the OTA. The modified successive-approximation ADC allows rail-to-rail inputs.